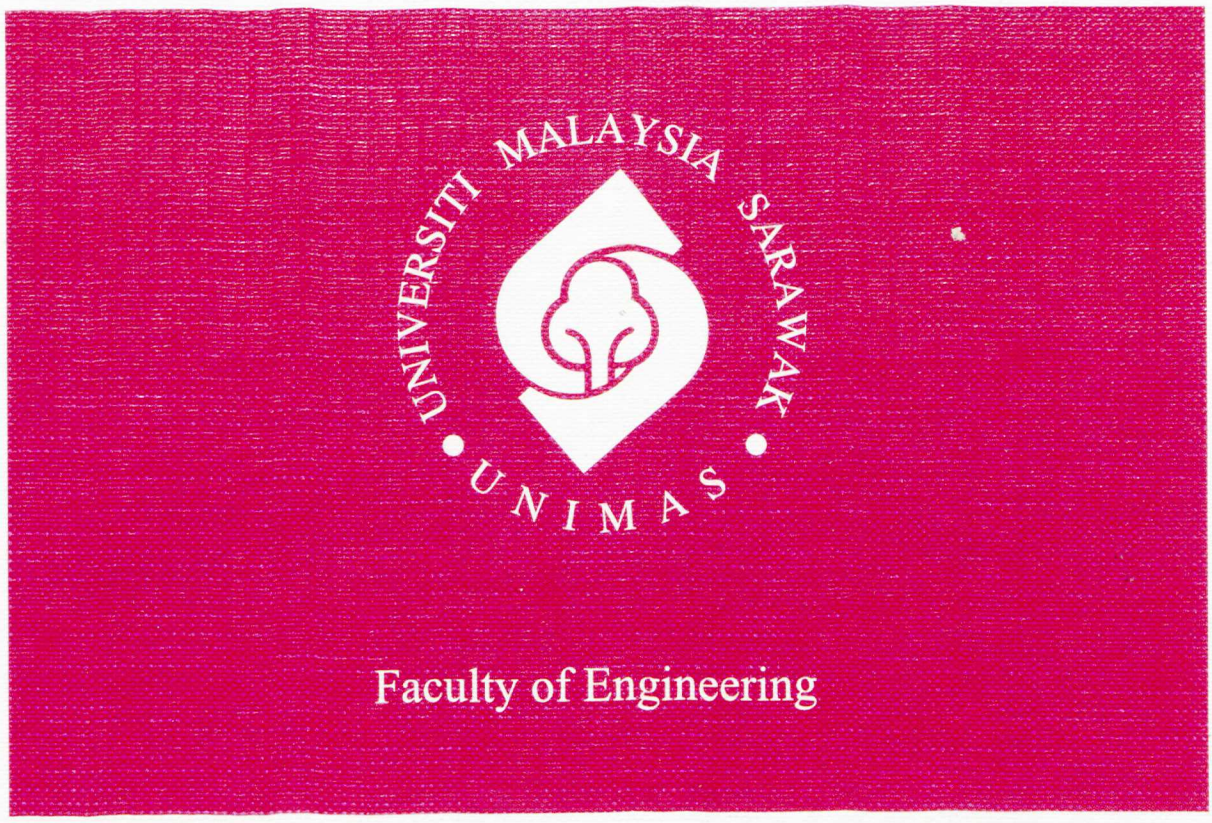

FEASIBILITY STUDY OF USING ETHANOL AND PETROL BLENDS IN MALAYSIA

Angelina Eno John Sikos

Bachelor of Engineering with Honours
(Chemical Engineering)
2013

UNIVERSITI MALAYSIA SARAWAK

Grade: _____

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This final year report which entitled **"Feasibility Study of Using Ethanol and Petrol Blends in Malaysia"** was prepared by Angelina Eno John Sikos (23142) as a partial fulfillment for the Degree of Bachelor of Chemical Engineering is hereby read and approved by:

ASSOCIATE PROFESSOR DR KHAIRUDDIN SANAULLAH
(Supervisor)

20 May 2013
Date

FEASIBILITY STUDY OF USING ETHANOL AND PETROL BLENDS IN MALAYSIA

ANGELINA ENO ANAK JOHN SIKOS

Report is submitted to

Faculty of Engineering, University Malaysia Sarawak
In Partial Fulfilment of the Requirements for the Degree of Bachelor of Engineering with Honours
(Chemical Engineering)

2013

Dedicated to my beloved parents, who always being there for me; persistently giving supports and motivations

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To those who indirectly contributed, your kindness means a lot to her. Thank you very much.

ABSTRAK

Bioetanol yang dihasilkan daripada biomas lignoselulosa boleh dilihat sebagai sumber tenaga alternatif di Malaysia. Ini adalah disebabkan oleh kekurangan bekalan petroleum dan harga akan dijangka meningkat secara mendadak. Selain itu, kebimbangan utama adalah pencemaran yang dihasilkan dari pembakaran bahan api fosil. Bahan-bahan mentah yang terdapat di Malaysia adalah tandan buah kosong kelapa sawit (EFB), batang pisang dan sagu hampas. Ketiga-tiga dibandingkan berdasarkan hasil gula, hasil etanol tahunan dan keluasan. Dari hasil perbandingan, hampas sagu telah dipilih sebagai bahan mentah yang paling sesuai. Bagi bahagian eksperimen, etanol telah dicampur dengan petrol (RON95) untuk menentukan nilai kalori. 11 campuran ujian antara 0 peratus hingga 100 peratus etanol dengan peningkatan sebanyak 10 peratus telah digunakan. Eksperimen mununjukan gabungan yang lebih tinggi mempunyai nilai kalori yang lebih rendah dan perbatuan yang tinggi. Dari analisis ekonomi, ia menunjukkan bahawa penghasilan etanol dari hampas sagu boleh dilaksanakan. Walau bagaimanapun, berbanding dengan harga gula, harga campuran etanol tidak menguntungkan untuk dihasilkan. Perbandingan harga E20 dengan peratusan perbatuan juga tidak menguntungkan.

Kata kunci: bioetanol, nilai kalori, sagu hampas, batang pisang, perbatuan, tandan buah kosong kelapa sawit, campuran etanol, petrol

ABSTRACT

Bioethanol derived from lignocellulosic biomass can be seen as an alternative energy source in Malaysia. This is due to the depletion in petroleum supplies and the prices are expected to increase sharply. Other major concern is the pollution originating by burning fossil fuel. The possible raw materials in Malaysia are oil palm empty fruit bunch (EFB), banana stem and sago hampas. These three were compared based on sugar yield, annual ethanol yield and the acreage. From the comparison, sago hampas is chosen as the most feasible raw material. For experimental design, ethanol is blended with petrol (RON95) to determine the calorific value. 11 test blends ranging from 0 percent to 100 percent ethanol with an increment of 10 percent were used. The result of the experiment shows that the higher blends have lower calorific value and high mileage losses. From the economic analysis, it shows that the production ethanol from sago hampas is feasible. However, when compared with sugar price, mileage losses and the price the blend, ethanol is not feasible to be used.

Keywords: bioethanol, calorific value, sago hampas, banana stem, mileage, oil palm empty fruit bunch (EFB), ethanol blends, petrol

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ABBREVIATIONS

°C	Degree Celsius
g	Gram
g/L	gram per liter
EtOH/d	Ethanol per day
h	Hour
ha	Hectare
kCal	Kilo Calorie
kg	Kilogram
Kg/cm^2	Kilogram per centimeter square
kJ	Kilo Joule
L	Litre
mg/g	Milligram/gram
M^3/d	Cubic meter per day
psig	Pounds per Square Inch Gage

NOMENCLATURE

^{o}C	Degree Celsius
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPO	Crude Palm Oil
CV	Calorofic Value
EFB	Empty Fruit Bunch
GHG	Greenhouse gases
HCV	High Calorific Value
LDV	Light-duty Vehicle
Mtoe	Million tonne of oil
Proálcool	National Fuel Alcohol Programme
SIRIM	Standard and Industrial Research Institute of Malaysia
SO_2	Sulphur Dioxide
USD	United State Dollar

CHAPTER 1

INTRODUCTION

1.1 Introduction

About 82% of the world's energy needs are presently covered by fossil resources such as petroleum, natural gas and coal (World Energy Council, 2012). According to Shuit et al. (2008), based on 2005 data, about 93% of Malaysia energy consumption depended heavily on fossil fuels (natural gas, coal, diesel and oil) and only 0.5% of the energy came from renewable sources such as biomass (excluding hydropower). Today, fossil fuels are used by society around the world for fuel energy productions. The consumptions of petroleum products represent 94% of energy use in the transportation sector. For mineral oil, about 60% was used for transportation in 2004 (Reijnders & Huijbregts, 2009). The rapid consumption of fossil resources caused the reserves of these fuels being quickly depleted.

According to Shuit et al. (2009), fossil fuel reserves are predicted to last only for another 30 to 40 years in Malaysia. So, Malaysian government has to start looking for reliable source of renewable energy urgently. This scenario become more vital as the price of crude oil in July 2008 was at USD 121.91 per barrel and Malaysian government needs to spend a lot on subsidiary to keep the cost of energy especially transportation fuel low. Malaysia's fuel subsidiaries

cost the country about RM40 billion in 2007 alone (Shuit et al., 2008). **Figure 1.1** shows the energy demand in Malaysia that indicates a speedy increase in demand. For the year 2030, the energy demand is expected to be almost 100 Mtoe (million tonne of oil) (Asia-Pacific Economic Cooperation, 2006).

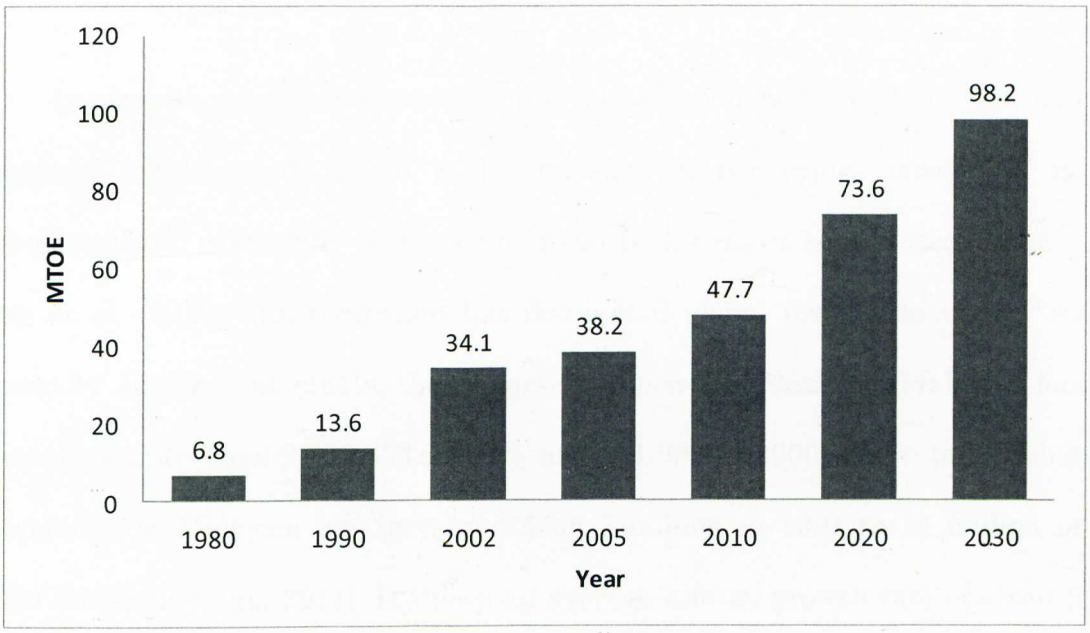

Figure 1.1 : Energy demand in Malaysia (Suit et al.,2009).

Too limited fuel reserves may lead to high inflation of economy. In the middle of the first decade of the 21st century, dramatic increase in the prices of crude oil focused political and public attention on the role of biofuels. In the new millennium, it has been widely accepted worldwide that global warming is the greatest threat and challenge (Shuit et al., 2009). In order to stop global warming and to promote sustainable development, renewable energy is a perfect solution.

Therefore, an alternatives fuel has been created to reduce the cost, increase profitability and provide less pollution to human and environment. An alternative to this concern is blending of gasoline with ethanol. Importantly, the

alternatives fuel must be technically feasible, economically competitive, environmentally acceptable and readily available.

1.2 Transport Sector in Malaysia

Impressive economic success in the last three decades in Malaysia had triggered urbanization. It led to an increase in per capita income of its population and eventually increases demand in transport sector. According to Ong et al. (2012), transportation has dominated global fuel consumption. As stated by Aizura et al. (2010), the ownership of private vehicles in Malaysia has increase rapidly from 2,553,574 in 1995 to 6,941,996 in 2006. The total number of vehicles in Malaysia has increased from 5 million in 1991 to 19 million in 2009 (Mustapa et al., 2011). It shows an average annual growth rate of about 8 % during this time. The increasing in the number of vehicles in the country has been more rapidly than the growth in population. Average annual growth rate is 2.5% in 1991 to 2009.

After industrial sector, transportation sector is the second most energy consuming sector for about 40% of the total energy consumption in Malaysia (Aizura et al., 2010). It is one of the most energy intensive sectors and relies mainly on petroleum product. **Table 1.1** shows that transportation is the second largest sector of using energy in Malaysia in 2010 as estimated by the Malaysian Energy Commission (Devaraj, 2012).

Table 1.1 : Energy consumption in Malaysia in 2010 (Devaraj, 2012).

Sector	Energy use in kilo tonnes oil equivalent	Percentage of total energy use
Power Station	33,294	50.5
Residential	718	-
Commercial	1,722	-
Industrial	8,621	13.1
Transport	16,809	25.5
Agriculture	1,050	-
Total	**65,910**	-

Road transport is the primary energy consumption within the transportation sector. According to Mustapa et al. (2011), the share road transport in the total energy consumption of the transport in 2008 was the highest at 80% as shown in **Figure 1.2.**

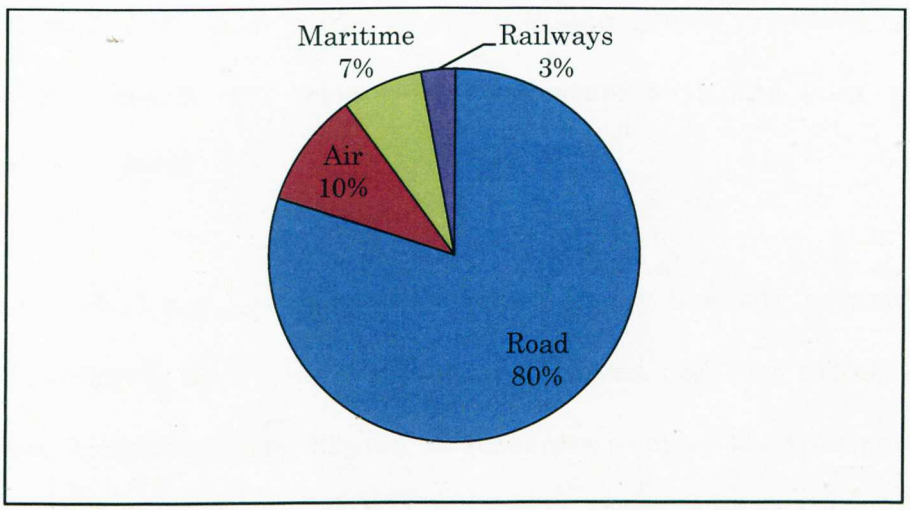

Figure 1.2 : Proportion of energy consumption by transportation type (Mustapa et al., 2010).

The increasing energy demand compounded with fuel subsidies and a volatility of oil price has set the transport sector on an unsustainable course threatening to national energy security. In addition, heavy reliant on petroleum causes the transport sector in Malaysia to contributes significantly to the greenhouse gas emissions. Malaysia has set a voluntary target to decrease its carbon intensity by 40% by 2020. Clearly, transport system will be among the first issues that need to be concerned of. Two-third of the emissions comes from fuel combustion in the sector as 80% of vehicles are still running with petrol fuels. Due to that, greenhouse gas emission has risen in an alarming rate. Petrol consumption for road transport has a rapid growing rate than other sector. The trend seems to be quickly moving upwards in the near future.

Air pollution happened vigorously in developing countries especially in road transport sector. The growing demand of petroleum based fuels and their combustion in internal combustion engines have bad effect on air quality, human health and global warming. Air pollution causes breathing problem, increase high health care service cost, premature birth and even mortality (Liaquat et al., 2010).

It is a challenge for Malaysia to reduce energy intensity particularly in terms of petroleum fuels used in the sector. Malaysia predicted increase in the energy use in transport and limited oil resources to move the transport sector towards better diversification in fuel. Transport sector is greatly dependent on petroleum products which are almost 98% of the total consumption. As stated by Mustapa et al. (2010), petrol accounts for the largest share which is 54% of the energy demand of the transport sector among the petroleum products. The

consumption of petrol has been increase rapidly with growing motorization and increase dependence on private mode.

This has caused much concern in many countries including Malaysia to improve the sustainable energy of this sector (Ong et al., 2012). There is short of diversification of fuel basket for the transport sector. One of the ways to diversify fuel mix is by promoting biofuels. Biofuels used as transport fuel has high vision in developing countries. According to Liquat et al. (2010), it is due to the severe energy insecurity and has strong agriculture sector to support the production of biofuels. Production of biofuels promises enough improvement in air quality through reducing emission from biofuels operated automotive. Some of the developing countries have started biofuel production and utilization as transport fuel in local market.

A good example in Malaysia is the usage of B5 biodiesel which means 5% palm oil-based methyl ester blend in conventional diesel (Mustapa et al., 2010). Since 2006, priority has been given on the promotion of biodiesel and also the introduction of National Bio-fuel Policy. The usage of B5 in government vehicles started in February 2009 with 5.49 million litres. In June 2011, mandatory sales of B5 started in Malaysia. RM250 million a year is spent by the Government to subsidise a 5% blend of biofuel.

1.3 Problem Statement

Nowadays, the rise in world population eventually increases the demand of automotives industry especially in car selling. This causes a substantial rise in demand for fuel. As the result, there will be depletion in petroleum supplies and

the prices are expected to increase sharply. Other major concern is the pollution originating by burning fossil fuel. Examples of bad consequences include the greenhouse emissions, air pollution, acid rain, which are detrimental to the environment and our health.

From a scientific data, hundreds of millions of people could lose their lives if average global temperatures increase by more than 2°C (Shuit et al., 2009). Besides that, up to one million species of animals and plants are currently at the threat of extinction. In order to meet the growing demand of energy and to decrease the emission of carbon dioxide while ensuring sustained supply of energy, Malaysia needs to find an effective and sustainable source of energy. If effective steps are not taken, Malaysia will become a net importer of fossil fuel mainly oil and gas when reservoir of oil and gas dried up soon. Thus, it is vital that the Malaysian government has to think seriously for developing alternative energy resources.

There are ranges of alternative fuel used in cars that have being developed. Examples of alternative fuel are acetone, methanol and ethanol (Schott, 2009). These fuels have been in use successfully for sometimes such as Brazil, but the scope of alternative fuels in Malaysia is still limited (Kennedy and Ahamad, 2007). Demand for bio-ethanol as alternative fuel in Malaysia is still low since most of the vehicles in this country are still running on petrol. There is no large-scale production of bio-ethanol in Malaysia because of the low demand.

However, in a country that is extremely rich of natural resources and products such as Malaysia, biomass can successfully become a potential for